ILC Detector R&D in CD: An Overview

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Agenda

Title	Presenter	Time (min)
Overview	Rob Kutschke	15
SiD Simulations and Benchmarking	Rob Kutschke	15
SiD Forward Tracking	Hans Wenzel	15
Progress and Plans	G.P. Yeh	15
Hardware Acquisition Plans	Lynn Garren	15
IDS Roadmap (maybe)	Mark Fischler	15

ILC Detector Work at FNAL

- R&D for vertex detector and tracking hardware.
  - Marcel Demarteau, Ron Lipton, Bill Cooper
- Muon detector design and physics with muons
  - Gene Fisk, Caroline Milstene
- Physics Benchmarks
  - Aurelio Juste, Rob Kutschke, John Yoh
- SiD Detector Simulations
  - Lynn Garren, Mark Fischler, Rob Kutschke, Hans Wenzel
- Other
  - Adam Para(Calorimetry), G.P. Yeh (4th concept)

This ILC Forum is about work by names in red

External Drivers

- ILC descoped to one IR (10% $ savings).
- Two detectors retained:
  - Redundancy, competition.
  - Push-pull. Goal: switch-over O(1 week)!!!!!!
  - Ideally optimized for different physics scenarios !!!!
- The ILCSC asked WWS co-chairs to develop a "detector roadmap". link????
  - Worry: delayed decisions can jeopardize the project.
  - Insufficient resources to keep all options on the table for all detector concepts to completion of TDRs.
    - Aggressively reduce duplicated effort.
    - Down select earlier if that is not enough.
  - Goal: Detector TDRs in 2010 (machine TDR time).

The Detector Roadmap

- 2010: detector design must be at a "similar stage of maturity" to that of the accelerator.
- Timeline:
  - Fall 2008: CDRs from all detector concepts.
    - Concept ≠ Collaboration
  - Down-select to 2 detectors.
    - Form official detector collaborations at this time.
    - Must get this part right!
      - Retain options!
      - Reduce funding for low priority ideas/options!
  - Fall 2010: TDRs due.
  - Ready to build by 2012.
- Background hope: self-merging before down-select.
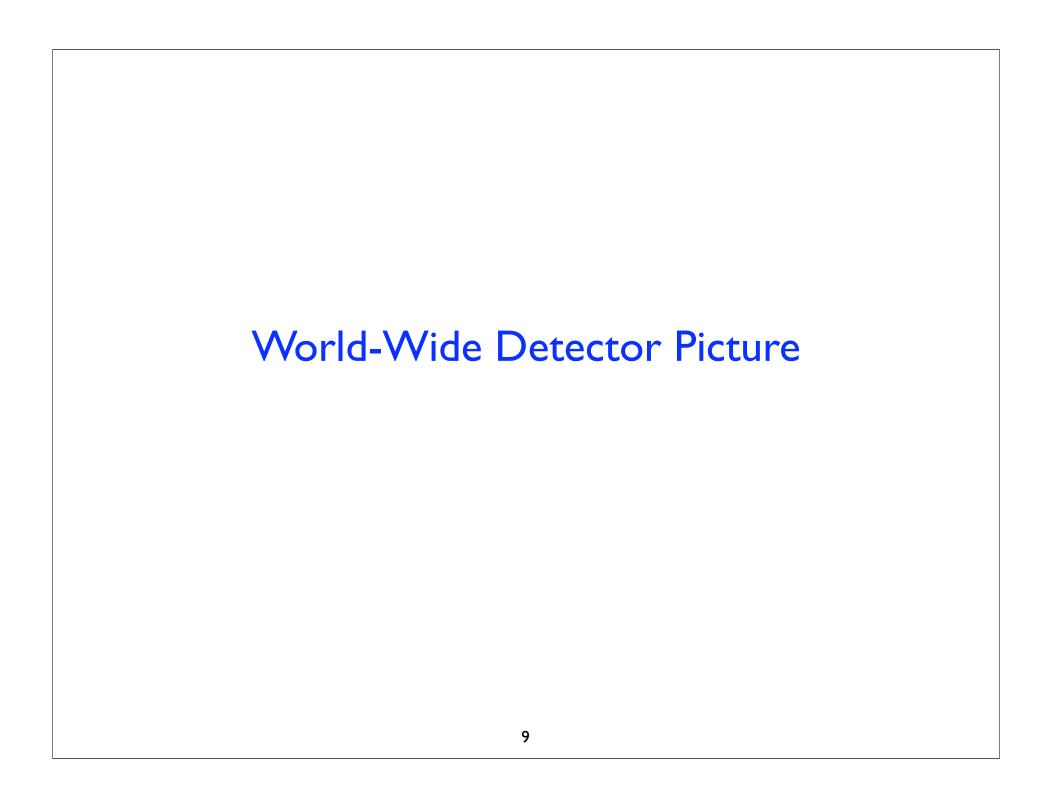
Inconvenient Truths

- Very unlikely that R&D done between now and fall 2008 will permit a clear choice among the competing options.   Even by 2010!
- ILC community will not have resources to do a real TDR, even for one detector, by 2010!
- We can fail both ways, by deciding too late or by deciding too soon.
  - NASA is now launching satellites with technology frozen 20 years ago.
  - Presumption is that we are less "locked in" than is NASA since NASA needs to space qualify every fasterner and screw.

My View

- Important to set significant milestone for fall 2010.
  - Long enough for significant work to be done.
  - Need to have an up to date response if there is a discovery at the LHC or TeV.
- It won't really be a true TDR since we won't get the resources to do it.
  - It will be a snapshot of the technical design process.
  - It can be "at the same level as that of the machine".
  - I prefer not to call it a TDR but ...
- Key is to retain appropriate options at down-select.
  - If two detector concepts differ only in calorimetry, there is no reason to duplicate the effort to design of the rest of the detector.

Relevant Deadlines

- ALCPG October 22-26, 2007 at FNAL
  - Major status report.
  - Bonus points for showing the flag.
- Spring 2008
  - Software for CDR benchmarks essentially complete.
  - CDR benchmark studies underway.
  - Start writing CDR.
- Fall 2008
  - Submit CDR.

World-Wide Detector Picture

Detector Concepts (July 2007)

- **SiD**
  - US based. All silicon tracking. PFA calorimetry.
- **GDC/LDC**
  - Merged just before DESY meeting:
    - GDC: Global Large Detector. Asian based.
    - LDC: Large Detector Concept. European based.
  - Pixel Vertex/TPC tracking/PFA calorimetry.
- **4TH Concept**
  - DREAM CAL (Dual REAdout Modules).
  - Considering all tracking options.
  - By far the smallest group.
    - At Argonne told they are too small to survive on their own.
    - Some suggest their calorimeter become an option on SiD.

Comparing Detectors

Detector	Vertex Detector	Tracking System	ECAL	HCAL	Muon/Tail Catcher
SiD	Si Pixels	Si Strips	W/Si-Pixels		
GDC/LDC	Si Pixels	TPC			
4th	Si Pixels	TPC/ CLUCOU/ Si Strips	Dual Readout (DREAM)		

Finish this page!!!

World Wide Software Status (1)

- I have personally only run SiD software.
  - Some reconstruction code that SiD says works, actually ran in an NLC-era framework and has never been ported to the new one.
  - My perception is that LDC is more advanced.
- 4 Detector concepts
  - 4 Frameworks and 4 build environments.
- Efforts at standardization between SiD and LDC:
  - LCIO: event IO.
  - LCDD: geometry description.
  - Both are incomplete (details in backup slides).
  - Others groups would like to join these efforts but it is a low priority.
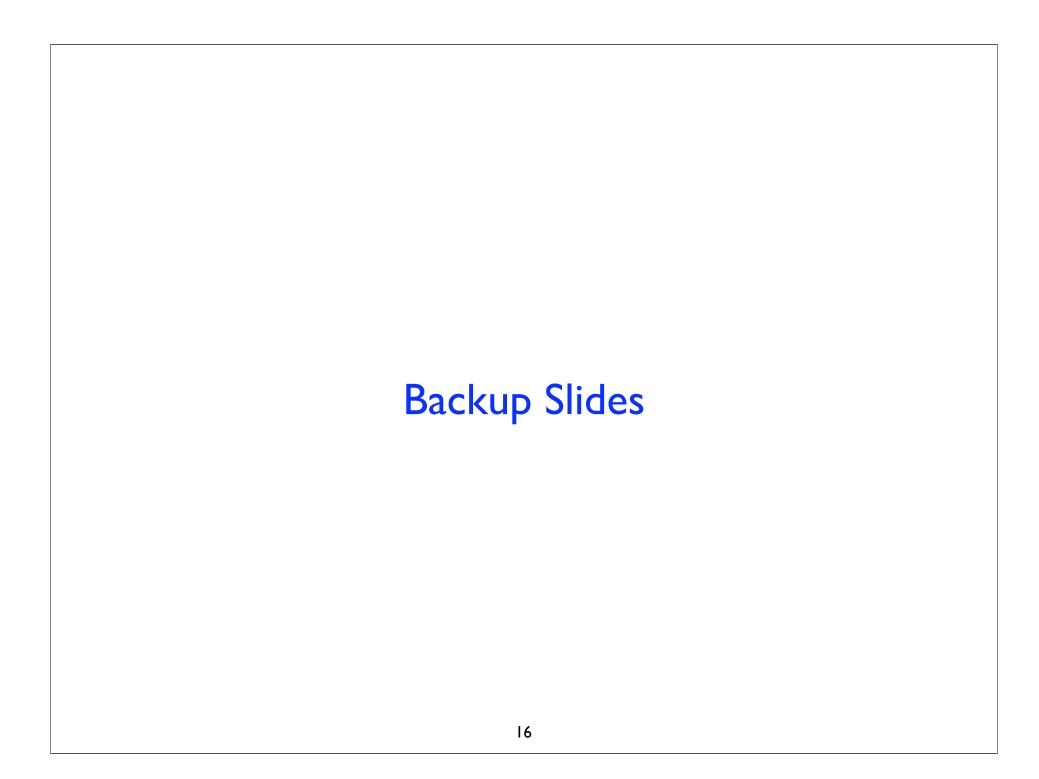
World Wide Software Status (2)

- Goal: highly interchangeable data
  - Run event generator in framework A, detector simulation in framework B, reconstruction in framework C and analysis in framework D.
- I view this as just silly.
  - Doable for toy detectors, not realistic ones.
  - A much more limited version makes sense
  - Exchange stdhep files and reconstructed objects, neither of which depends much on internal details of the detector.
- Someone has actually run their PFA on both SiD and LDC events.
  - Check with Norman. Who. How toy/real?

The IDS Team at FNAL/CD

Lynn Garren	System admin; software deployment, maintenance and development; web site development.
Mark Fischler	Planning and oversight.
Rob Kutschke	Tracking and vertexing reconstructionsoftware; benchmark analysis.
Adam Para	Survey of calorimeter technologies.
Hans Wenzel	SiD forward tracking software. Sim and reconstruction.
G.P. Yeh	4th concept.
Summer Students:	
Francisco Ruiz	FNAL student from IPN Mexico; working with Hans.
Daniele Barbareschi	INFN Lecce (4th concept) paid by PPD; working with Hans.
Related people:	
Caroline Milstene	PPD finishing papers on physics with muons. Plus a summer student.

Summary

- Detector Roadmap will be adopted in something like the form presented.
- We are down to 3 detector concepts.
  - Some suggest SiD and 4th merge?
- Lots of software, lots of duplication, little coherence.
  - Some silly ideas.
- Deadlines
  - October/07: ILC workshop at FNAL
  - Spring 08: Major s/w R&D complete
  - Fall/08: Submit CDR

Backup Slides

Some Detector Challenges

- Jet energy resolution:
  - Separate W→jet jet from Z→jet jet.
    - $\sigma(m(\text{jet jet})) <$ 3 or 4 GeV, independent of E(jet jet).
    - Often specified as $\sigma(E)/E \leq 30\%/\text{sqrt}(E)$ or as flat Check $\leq 3\%$.

- Momentum resolution:
  - Resolve a very narrow, low mass H→μμ.
  - $\sigma(p_T)/p_T \leq 2 \times 10\text{-}5$ Check number and units.

- Extend both of the above farther in to the forward region than ever before.

- Robust against enormous background from beamstrahlung.

World Wide Software Status

- 4 Detector concepts
  - 4 frameworks and 4 build environments.
    - Frameworks: Two C++; one Java; one root based.
    - Evolved from legacy NLC, JLC ...
  - All use can G4 for simulations (GHEISHA/FLUKA?)
- Geometry
  - Everyone has their own tool to digest a geometry description to feed G4 and their own reco code.
  - LCDD:
    - Linear Collider Detector Description.
    - Can be digested by both Europeans and SiD.
      - Others have talked about joining.
    - Only geometry, not material properties.
    - Extension to include material properties promised.
      - Time scale not known.

World Wide Software Status (2)

- LCIO:
  - Joint effort by SLAC and Europeans for event IO.
    - Asians and 4th have talked about coming on board.
  - APIs for Java, C++, Fortran.
  - Weaknesses:
    - No schema evolution.
    - Persistent classes are not very functional for tracking.
    - Crashes if it reads an unrecognized block.
      - Fixed in a recent release that I have not yet tried.
    - No provenance.
    - Collection names free form. No enforced conventions.
  - Bi-directional relations between objects.
  - Coming: new version (root-io back end?).
    - Time scale not known.

World Wide Software Status (3)

- LCFI
  - Linear Collider Flavor Initiative
  - Code to flavor tag jet using vertexing and leptons-in-jets.
  - C++ only but concept agnostic.
  - Hope to use in SiD by writing jets to LCIO files and running code in its native environment.

org.lcsim

- Java based.
- Can be run standalone or within JAS3.
  - Documentation/examples are JAS3-centric.
- Framework runs the event loop and executes a list of "drivers" specfied by the user.
- Driver:
  - What other frameworks call a module.
  - Callable from the framework:
    - Detector change; process event; end of data ...
  - Can read event and add collections to the event.
  - Can overwrite/delete collections in an event.
- Native histogram/tuple environment: aida.
  - Display tools not as rich as root.

org.lcsim (2)

- Reconstruction code lives in user areas and is not vetted by anyone.
- Little discipline among users to ensure that their codes cooperate.
  - Predefined classes are not rich enough for the job.
    - So everyone makes their own private extensions.
    - Can add these objects to the event - but no persistency.
- No method to stop my histograms or collections from stomping on yours.
- Various "full" reconstruction codes are advertised:
  - Some ran in JAS2 and are not yet ported to JAS3.
  - Documentation by calling the author.
  - I have not yet run any of them.

org.lcsim (3)

- **Release model**
  - Infrequent releases.
  - Users: copy current .jar files from SLAC
  - Developers: build the head
    - You just gotta know when the head is/was in good shape.
- **Each user keeps current .jar files in ~/.JAS3**
  - Deploying a new release clobbers the old one and you cannot backtrack unless you saved a copy ahead of time or know the check out time of the old version.
- **Presumes that you always have internet access.**
  - It does cache things but you may need to know in advance if you need to force caching.

Magic Words and Phrases

- ILCSC: ILC Steering Committee
  - An adhoc body with influence but no money.
- WWS: World Wide Study
- CDR: Conceptual Design Report
- DCR: Detector Concept Report
  - A attachment to the RDR.
- TDR: Technical Design Report
- RDR: Reference Design Report
  - The design document for the Accelerator that was released in Beijing. Review is complete about now.
- PFA: Particle Flow Analysis
  - A calorimetry concept.

Magic Words and Phrases

- PFA: Particle Flow Analysis
- Dual Readout Calorimetry
  - Measure both Cerenkov and Scintillation light to separate EM and Hadronic response.
- DREAM
  - Dual REAout Module,
- IDS: ILC Detector Simulations (our group in CD).